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10/063,896	05/22/2002	Hsin-Chang Wu	NAUP0498USA	2378

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EXAMINER	
PADGETT, MARIANNE L	
ART UNIT	PAPER NUMBER
1762	

DATE MAILED: 04/07/2004

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No. 10/063,896	Applicant(s) Wu et al
	Examiner M.L. Padgett	Group Art Unit 1762

—The MAILING DATE of this communication appears on the cover sheet beneath the correspondence address—

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, such period shall, by default, expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

☐ Responsive to communication(s) filed on ______.

☐ This action is **FINAL.**

☐ Since this application is in condition for allowance except for formal matters, **prosecution as to the merits is closed** in accordance with the practice under *Ex parte Quayle,* 1935 C.D. 1 1; 453 O.G. 213.

Disposition of Claims

☒ Claim(s) 1-18 is/are pending in the application.

Of the above claim(s) ______ is/are withdrawn from consideration.

☐ Claim(s) ______ is/are allowed.

☒ Claim(s) 1-18 is/are rejected.

☐ Claim(s) ______ is/are objected to.

☐ Claim(s) ______ are subject to restriction or election requirement

Application Papers

☐ The proposed drawing correction, filed on ______ is ☐ approved ☐ disapproved.

☐ The drawing(s) filed on ______ is/are objected to by the Examiner

☐ The specification is objected to by the Examiner.

☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. § 119 (a)-(d)

☐ Acknowledgement is made of a claim for foreign priority under 35 U.S.C. § 119 (a)-(d).

☐ All ☐ Some* ☐ None of the:

☐ Certified copies of the priority documents have been received.

☐ Certified copies of the priority documents have been received in Application No. ______.

☐ Copies of the certified copies of the priority documents have been received in this national stage application from the International Bureau (PCT Rule 17.2(a))

*Certified copies not received: ______.

Attachment(s)

☐ Information Disclosure Statement(s), PTO-1449, Paper No(s). ______

☒ Notice of Reference(s) Cited, PTO-892

☐ Notice of Draftsperson's Patent Drawing Review, PTO-948

☐ Interview Summary, PTO-413

☐ Notice of Informal Patent Application, PTO-152

☐ Other ______

Office Action Summary

1. Claims 2 and 10-18 are rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention.

Use of relative terms that lack clear metes and bounds in the claims, is vague and indefinite, unless provided with a clear definition of such in the specification or cited relevant prior art (definitions, not examples). In claims 2 or 11, see "low" used in "low-pressure" CVD or "high" in "high-density plasma." In claim 10, see "deep" describing "deep trench" and "hard" in "hard mask."

2. For clarity, it is recommended that acronyms and abbreviations, such as "BSG" used in the claims, be written out in full on their first usage in a claim sequence, as is done in paragraph [0002] of the specification.

It is also noted, that in claims 7 and 16, since "oxygen" can be either the generic term for the element regardless of its state or what it may or may not be bonded to, or can be the gaseous form O_2, that "oxygen-containing plasma comprises...oxygen plasma" (emphasis added) can be considered to encompass the same scope. Thus, while these claims provide specific suggestions, they do not as written necessarily further limit the "oxygen-containing plasma" limitation. Note use of O_2 would specify the form of the oxygen.

3. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

This application currently names joint inventors. In considering patentability of the claims under 35 U.S.C. 103(a), the examiner presumes that the subject matter of the various claims was commonly owned at the time any inventions covered therein were made absent any evidence to the contrary. Applicant is advised of the obligation under 37 CFR 1.56 to point out the inventor and invention dates of each claim that was not commonly owned at the time a later invention was made in order for the examiner to consider the applicability of 35 U.S.C. 103(c) and potential 35 U.S.C. 102(e), (f) or (g) prior art under 35 U.S.C. 103(a).

4. Claims 1-18 are rejected under 35 U.S.C. 103(a) as being unpatentable over Yamada et al (6,465,359 B2) or Liu et al (6,380,095 B1); in view of Gulett et al (4,330,569) or Nagahisa et al (5,888,855) or Moore et al (6,323,139 B1); optionally further considering Ohtaka et al (5,108,843).

In either Yamada et al or Liu et al, it is taught to deposit the claimed sequence of layers: oxide layer/Si-nitride/BSG used as masks for etching patterns, such as trenches, contact holes, etc., however neither Yamada et al nor Liu et al treat the Si_3N_4 layer with an O-containing plasma. In Yamada et al, see the abstract; figures, such as Fig. 2; col.1, lines 14-26 and 42-67, noting suggestion of plasma depositions and teachings of Si dioxide here in include both undoped and doped, such as BSG, PSG or BPSG (being a dopant indicates relatively small percentages, esp. by weight for a light element); col.3, lines 1-30; col.4, lines 42-45; and 64-67; col.7, lines 39-67+ for coating sequence preparatory to plasma-etching dry), noting SiO_2 layer above Si_3N_4 may be a doped glass or TEOS deposited or SOG (spun-on glass) deposit, and use of antireflective coating is also optionally taught; and in col.9-10, extensive teachings on etch rates of the SiO_2 (possible BSG) and SiN_x for various etch gas combinations or concentrations

are taught, such that one of ordinary skill would have considered when determining needed thicknesses to produce desired depth of etching for specific dry etchant gases. In Liu et al, see the abstract; figures, esp. 1, 3-6; col.1, lines 11-15 and 30-55, noting use for deep trenches, and equivalent use of BSG and TEOS Si oxide layer after Si nitride, as well as optional use of Si oxynitride antireflective layers; col.4, lines 38-46; col.5, lines 16-25; col.6, lines 38-40 and 52-55 col.7, lines 65-col.8, line 15, with teachings of exemplary thickness of BSG at 7000 ´, Si nitride at 2200 ´; and pad oxide at 80 ´, providing values insignificantly different from the about 7500 ´ and about 2000 ´ claimed.

In Gulett et al, it is taught to plasma treat a Si nitride layer on an oxide layer, with ionized oxygen in order to improve its adhesion characteristics, in preparation for subsequent processing, exemplified by spin-on coating of an organosilane solution, such as HMDS. The O-plasma may use dry oxygen gas, be applied for 10-15 minutes, with the exemplary apparatus using 280 watts, and is proposed to enhance the adhesion by converting a very thin layer of the nitride to oxynitride.

It would have been obvious to one of ordinary skill in the art to apply Gulett et al's O-plasma conditioning step for Si nitride films to Yamada et al or Liu et al for its taught improved adherence for subsequent masking coatings that would have been expected to be analogous to taught techniques employing organosilicon or to SOG deposits due the use of homologous chemical reagents, as well as due to equivalence teachings in the primary reference to these films with BSG, and due to analogous enduses in photo resists and subsequent dry etching. See the abstract; figures; col.1, lines 13-21 and 58-68+; col.2, lines 17-24 and 56-col.3, lines 30 and 62-col.4, line 60; and col.5, lines 3-14 and 30-35.

Alternately, in Nagahisa et al, O-plasma denaturing of Si nitride to produce SiN_xO_y using N_2O or O_2 gases, in what may be a high frequency plasma apparatus in preparation for patterning. The Si nitride film may first be deposited in the same chamber via plasma, with exemplary parameters for O-plasma treatment using 10 sec., 1,300 W, 1.5 torr with N_2O gas. A range of oxidation times of 5 sec or more is also given, and oxygen content was measured at 50 atomic % at 100 ´ depth, but not substantially detected below 200 ´. See the abstract; figures; col.3, lines 1-5 and 40-col.4, line 55, esp. 40+ for teachings of improved adhesion that improves patterning uniformity and col.4, lines 11-21 for plasma types and gases; col.9, line 12-col.10, line 26 for the option of plasma depositing SiN_x then O-plasma denaturing it, before subsequent of mask patterning steps.

It would have been obvious to one of ordinary skill to apply the O-plasmas technique of Nagahisa et al to Yamada et al or Liu et al, for the expectation of improved adhesion between the taught Si nitride and hard masking layer options due to compositions, and given the suggested importance of improved adhesion to patterning quality.

Alternatively in Moore et al, see the abstract; Fig. 13-14; col.1, lines 24-44 for layer order and use of antireflective films; col.3, line 54-col.4, line 3 for the importance of adherence in any patterning technique employing resists; col.5 lines 59-67+; col.6, lines 12-57 for the alternative method of forming a barrier layer that is also an antireflective film via oxidation of a LPCVD nitride film to form $Si_xN_yO_z$ via use of one or more of O_3, NO or N_2O in either plasma, rapid thermal processing, or low or high pressure oxidation techniques; and col.8, lines 13-60 for further details, including suggested subsequent deposition of HMDS photoresists. It would have been obvious to one of ordinary skill in the art that the adhesion effects of Moore et al would

have been equally important in the primary references due to analogous organosilicon and/or Si oxide chemistry as discussed above; and because of taught desirable antireflective coating effects, especially given the optional suggestion of use of such films in conjunction with the BSG in Yamada et al or Liu et al.

Optionally, Ohtaka et al who teach the importance of matching interfacial compositions of Si oxide and Si nitride, by grading compositions (SiO_xN_y) in order to reduce stress, and to avoid separation of layers when using these materials as protective coatings (abstract; figures; col.1, lines 14-20; col.4, lines 45-57-double layer structures of SiO_2 + Si_3N_4 and PECVD or LPCVD processing; col.7, lines 1-61, and examples); provides further motivation for combining any of Gulett et al or Nagahisa et al or Moore et al with either Yamada et al or Liu et al, because it provides explicit teachings on why it is important to have a graded interface between silicon oxide and nitride layers, which is consistent with the adhesion teachings in any of the secondary references, and shows that the Si oxynitride layers produced by the plasma oxidation techniques thereof would have been expected to have been beneficial for SiO_2 coating regardless of whether or not they were derived from organosilicon compounds or inorganic precursors, hence would directly link the adherence effects to SiO_2 films, such as BSG.

It is further noted that oxygen containing plasmas tend to produce ozone in their gas mixtures, and that those with O_3 input will break down to an equilibrium with O_2 and various species, and that all of the secondary references suggest use of either ozone or O_2 as possible gases. While the PTO cannot measure the percentages of O_3/O_2 in these plasmas, the wide range of 2-50% would have been expected to have been within what would have been produced. Also while power in Watts was given in examples, no areas or power densities were, so values are not

directly comparable, however it would have been obvious to one of ordinary skill to determine such parameters via routine experimentation to provide taught oxidation, lacking any showing of unexpected results.

5. Other art of interest for showing layer deposition, patterning and trench formation as claimed include Shimonishi et al, Komada, Hong et al and Goldback et al. The patents of Tsai et al (6,319,814 B1) and Hsieh et al (6,521,300 B1) to overlapping inventors are of interest, but have claims differing in scope from those presently claimed.

6. Any inquiry concerning this communication or earlier communications from the examiner should be directed to M. L. Padgett whose telephone number is (571) 272-1425. The examiner can normally be reached on M-F from about 8:30a.m to 4:30p.m.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Beck Shrive, can be reached on (571) 272-1415. The fax phone number for the organization where this application or proceeding is assigned is 703-872-9306 for all official papers.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

Padgett/tgd 3/30/2004 & 4/1/04

Marianne L. Padgett

MARIANNE PADGETT
PRIMARY EXAMINER